Stability of a Sea Urchin Front in Southwest Nova Scotia

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by

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ABSTRACT

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Sea urchin (Strongylocentrotus droebachiensis) abundance and macrophyte cover was surveyed in 1979, nearshore west of Cape Sable Island. Parts of this area most likely to experience change in urchin abundance and macrophyte cover were resurveyed in 1981, and results of the two surveys are compared in this report. There were no marked changes in sea urchin abundance or biomass, there was little recruitment of urchins smaller than 3 cm diameter, and there was no general migration of high urchin densities toward shore. Area of kelp cover did not change, although on most transects the transition from good to poor cover of macrophyte understory was closer to shore in 1981. In summary, for most of the parameters measured, any change from 1979 to 1981 did not exceed the precision of measurement.

Key Words: Sea urchin, grazing, kelp, Nova Scotia

RÉSUMÉ

Miller, R.J. 1982. Stability on a sea urchin front in southwest Nova Scotia. Can. MS Rep. Fish. Aquat. Sci. 1662: v + 11 p.

Un relevé de l'abondance des oursins communs (Strongylocentrotus droebacheinsis) et de la couverture de macrophytes a été effectué près de la côte, à l'ouest du cap de

Sable en 1979. Les portions de cette zone considérées comme les plus susceptibles à des changements d'abondance des oursins et de couverture de macrophytes furent étudiées de nouveau en 1981. Nous comparons, dan le présent rapport, les résultats de ces deux relevés. L'abondance ou la biomasse des oursins n'ont pas beaucoup changé; le recrutement d'oursins de taille inférieure à 3 cm de diamètre a été très faible; et enfin les secteurs de forte densité d'oursins ne se sont pas déplacés appréciablement vers la côte. La zonne la couverture de varechs n'a pas varié, bien que, sur la plupart des coupes transversales, la transition entre une abondante et une pauvre couverture de macrophytes se fusse rapprochée de la côte. En résumé, pour la plupart des paramètres mesurés, tout changement observé de 1979 à 1981 est dans les limites de précision des mesures.

INTRODUCTION

In 1979, Biomarine Consulting Ltd. mapped the densities of the green sea urchin, Strongylocentrotus droebachiensis, and dominant macrophyte species in coastal waters west of Cape Sable Island in southwestern Nova Scotia (Wharton, 1980a). In 1978, Wharton (1980b) observed that this was the area of transition from urchin-dominated substrate to the east to dense macrophyte beds (Irish moss and kelp) to the northwest. Based on the 1979 survey, Wharton classified the area into four zones: pristine kelp, abundant kelp with sea urchins always present at low density and some evidence of sea urchin grazing, kelp and urchins present in moderate to high densities, and urchin-dominated barrens with high urchin density and kelp scarce. Wharton hypothesized that the front of urchin grazing would move northwest into Lobster Bay, an area supporing Irish moss harvesting and a lucrative lobster fishery.

In June, 1981, 14 of Wharton's transects located in the second and third zones as described above (Fig. 1) were resurveyed to test the hypothesis that the sea urchin front was moving toward Lobster Bay.

METHODS

1979

Samples were taken along a transect line of weighted rope marked at 1 m intervals laid on the bottom. A transect started at the top of the Laminaria zone (if this was not practical, distances reported were corrected for distance from the end of the line to the top of the Laminaria zone) and ran away from shore for 300-700 m. Prominent landmarks were chosen for starting points, and end points were designated by magnetic compass fixes on landmarks.

The station locations on the transect line were picked by scuba divers depending on the length of the line and the perceived changes in sea urchin density. Most transects were sampled at five to 16 stations. A few transects with predominantly unsuitable urchin habitat, mud or sand, were sampled at fewer stations. The following data were obtained at each station: density of small kelps, density of Laminaria longicuris, density of Laminaria digitata, density of Agarum cribosum, density of sea urchins, density of whelk species, density of Littorina sp., wet biomass of kelps, distance from

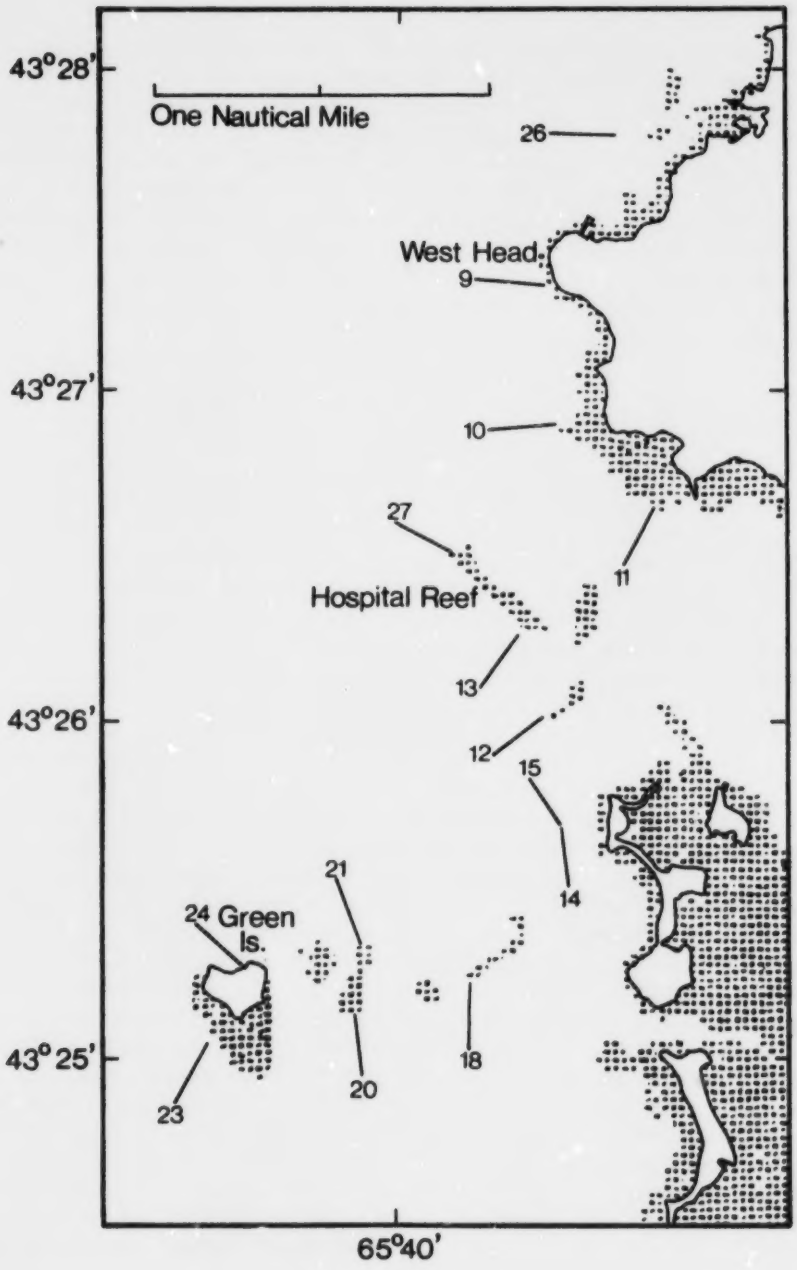

Figure 1. Location of transects surveyed in both 1979 and 1981 - Cape Sable Island, southwest Nova Scotia. Intertidal areas are stippled.

the top of the Laminaria zone (m), and depth below chart datum (ft). A qualitative description of substrate type and plant understory was recorded at each station and usually at additional points on the transect. Density and biomass data were taken for each of four, 1 m^2 circles positioned in cloverleaf fashion around the station mark on the line. Animal counts, urchin diameters, urchin weights, and kelp weights were taken from collections brought to shore. Station locations on a transect were sometimes divided into Laminaria-dominated, Agarum-dominated, and sea urchin-dominated. In this report, for comparison with the 1981 data, urchin collections from all stations on a transect were lumped.

1981

Fourteen transects from the 1979 survey were resurveyed. These locations were in the second and third zones (i.e. neither pristine kelp nor urchin barrens) and mostly over rock substrate. Given the accuracy limits to navigation in both surveys, I would estimate that transect locations were duplicated within 100 m. Substrate changes with distance from shore were repeated within tens of meters in the two surveys, with the exceptions noted in Table 1. A 300 m weighted transect line marked at 2 m intervals was set from the nearshore end as in the 1979 survey.

Typically, eight to ten stations were sampled per transect. These were chosen to span the length of the transect line, to avoid sand, and to represent areas where the sharpest gradients of sea urchin densities were observed in 1979. Thus, stations were closer over these gradients in 1981 than in 1979. At each station, sea urchins were collected from six, 0.25 m^2 quadrats. Two quadrats were sampled at each of three successive meter markings. Also noted at each station was the substrate type (rock, gravel, sand), percentage kelp cover on suitable substrate in the area, and relative density of understory (dense, sparce, none) on suitable substrate in the area. If a station were in an area of mixed sand and boulders, for example, kelp and understory cover on the boulders was estimated from looking at several square meters of bottom. In the laboratory on the same day as collection, the number, diameters, and weights of urchins were recorded.

Within transects, zones of transition in abundance of kelp, understory, and sea urchins were usually clear from both surveys. Kelp cover went from 100% to <50% or >700 g/m^2 to <200 g/m^2 between adjacent stations. Understory changed from qualitative designations of good or dense to poor, sparce, or thinning. The sea urchin density gradient was from <0.5 urchins/m^2 to >0.5 urchins/m^2. Sea urchins were large and densities were low throughout the study area compared to typical urchin-dominated grounds east of the study area along most of the south coast of Nova Scotia.

In the study area urchins were most abundant seaward of macrophytes. That is, dense macrophyte cover does not typically occur deeper and further from shore than urchin-dominated substrate. If urchins were abundant and macrophytes scarce closer to shore in 1981 than in 1979, I assumed the urchins were occupying more bottom to the exclusion of macrophytes.

RESULTS AND DISCUSSION

In the 1981 survey we looked for area-wide changes in macrophyte and sea urchin distribution and did not give much weight to changes on any one transect. This approach was adopted because changes in distribution of macrophyte and urchin-dominated grounds might be expected on any given transect without reflecting a general trend for this area. Also, to quantify with precision and accuracy observed changes on any given transect, a far greater sampling effort would have been required in both surveys. Furthermore, two or more permanent markers would have had to be placed on each transect in 1979 and relocated in 1981 to be able to accurately duplicate transect and quadrat locations.

No overall change in area occupied by kelp was detected from 1979 to 1981 (Table 1). The transition from good kelp cover or biomass to poor kelp cover or biomass was closer to shore on five transects (9, 15, 18, 21 and 24) in 1981 and was closer to shore on three transects (10, 13, and 20) in 1979. No clear change was found on another three transects (12, 23, and 27). On Transects 11, 14, and 26 the depth range or distance from shore of sand substrate suggested that transect locations were considerably different on the two surveys.

The transition from good to poor understory cover was generally closer to shore in 1981 (Table 1). Wharton (1980b) considers this the first stage in the creation of urchin-dominated grounds. This change occurred on seven transects (9, 12, 13, 15, 18, 24, and 27), whereas the reverse was true on three transects (10, 20, and 23). No change was apparent on Transect 21.

The transition from low to high sea urchin density was closer to shore on Transects 9 and 24 in 1981, while the reverse was true on Transects 23 and 27. There was no change on seven transects (10, 12, 13, 15, 18, 20, and 21) (Table 1).

Since transects were shorter and stations closer at transition zones in 1981, the two surveys are not unbiased samples of the same population of urchins. Even with this reservation, differences in mean urchin densities or biomass were not striking (Table 1). On only two transects were mean density and biomass more than two times greater in 1981 than in 1979. The reverse did not occur on any transect.

Table 1. Transect data for: density and biomass of sea urchins; distance from shore of transition from good to poor kelp cover; distance from shore of transition from good to poor understory cover; and distance from shore of transition from high to low sea urchin density.

Transect number	Year	m^2 sampled	Urchins/m^2		Good to poor kelp (m)	Good to poor understory (m)	High to low urchin density (m)
			numbers	grams			
9	1979	44	3.4	233	105–120	105–120	105–155
	1981	12	0.17	212	44	<30	80
10	1979	48	1.5	210	2–52	2–52	2–52
	1981	6	2.3	344	122–152	52–98	30–52
11	1979	24	0.9	107	160–210	210–250	110
	1981	13.5	1.8	187	180	180	180
	(sand 50 m further out and 4 m deeper in 1981)						
12	1979	36	1.4	141	150	150	<50
	1981	12	316.0	483	150–180	126–150	26–50
13	1979	36	3.3	298	60–100	100	10–60
	1981	12	3.9	330	100–110	10–40	40–60
14	1979	34	1.3	209	400	>300	105–155
	1981	10.5	12.3	1466	266–276	<76	<76
	(depth range 0.5–4.0 m – 1979; 3.0–5.0 m – 1981)						
15	1979	32	1.8	?	252–277	252–277	2–52
	1981	13.5	3.6	361	116–166	<66	<66
18	1979	?	2.2	177	160	150	<45
	1981	9	3.1	260	100–126	<30	30–60
20	1979	36	8.0	543	150–280	150	<30
	1981	9	9.1	867	<300	100–220	<30
21	1979	40	9.1	656	70–95	95	<70
	1981	13.5	13.8	1193	30–70	30	<30
23	1979	18	14.5	756	105–130	80–105	<5
	1981	12	11.8	718	120	106–120	30–56
24	1979	43	2.1	228	230	80–100	80–105
	1981	13.5	4.7	394	50	<30	<30
26	1979	40	0.8	100	205–255	105–155	355–405
	1981	27	0.7	102	156–300	256–300	246
	(sand 200 m nearer shore in 1981 survey; transect ran twice in 1981)						
27	1979	36	1.7	145	203–253	153–203	<5
	1981	13.5	1.7	331	240–256	106–156	156–240

Comparison of sea urchin size frequencies might suggest changes in cohort strength between years (Fig. 2). Size frequencies between years and within transects were compared with X^2 contingency tables. Frequencies were compared within 1 cm size classes and, where necessary, larger intervals were grouped so an expected value for a size class always exceeded four urchins. Size frequencies were significantly different on nine of 12 transects analyzed (Table 2). On seven of these nine transects, a shifting of the size-frequency distribution to the right in 1981, as would result from individual growth, could explain the significant chi-squares. On the remaining two of the nine transects a higher proportion of the urchins were smaller than 4 cm diameter, which might mean new recruitment or immigration. On no transect was there the large influx of new recruits expected for new urchin-dominated barren areas (Pearse, 1970; Lang and Mann, 1976).

CONCLUSIONS

1. Neither sea urchin density nor biomass showed marked change.

2. Growth of large sea urchins was evident from size-frequencies.

3. There was little recruitment of small sea urchins on any transect.

4. There was no general movement of high sea urchin densities closer to shore.

5. No consistent change was noticed in the area of kelp cover.

6. The area covered by macrophyte understory was probably reduced; i.e. the transition from poor to good coverage was closer to shore in 1981 on most transects.

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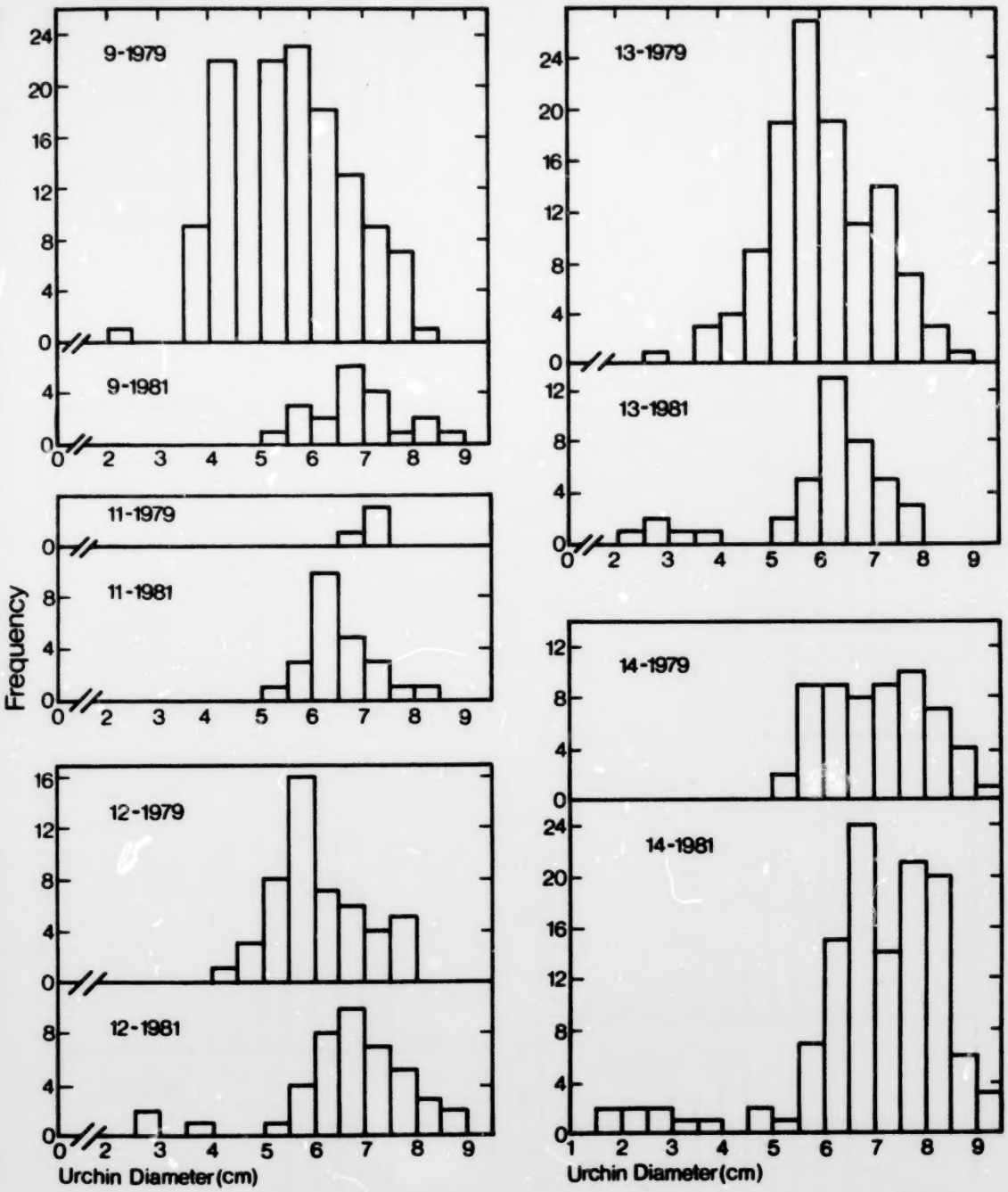

Figure 2. Size-frequencies of sea urchins by transect for 1979 and 1981.

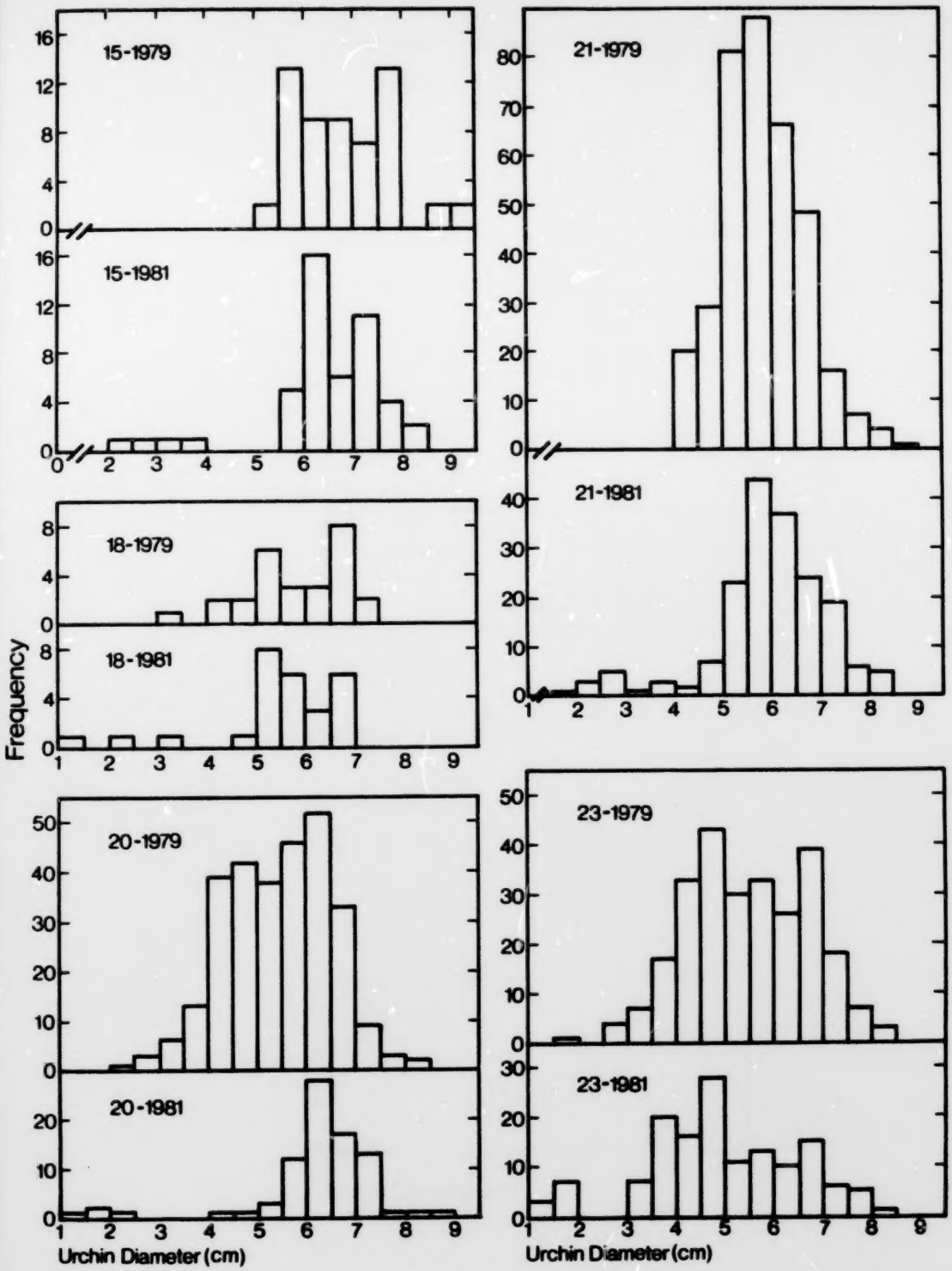

Figure 2. (cont'd)

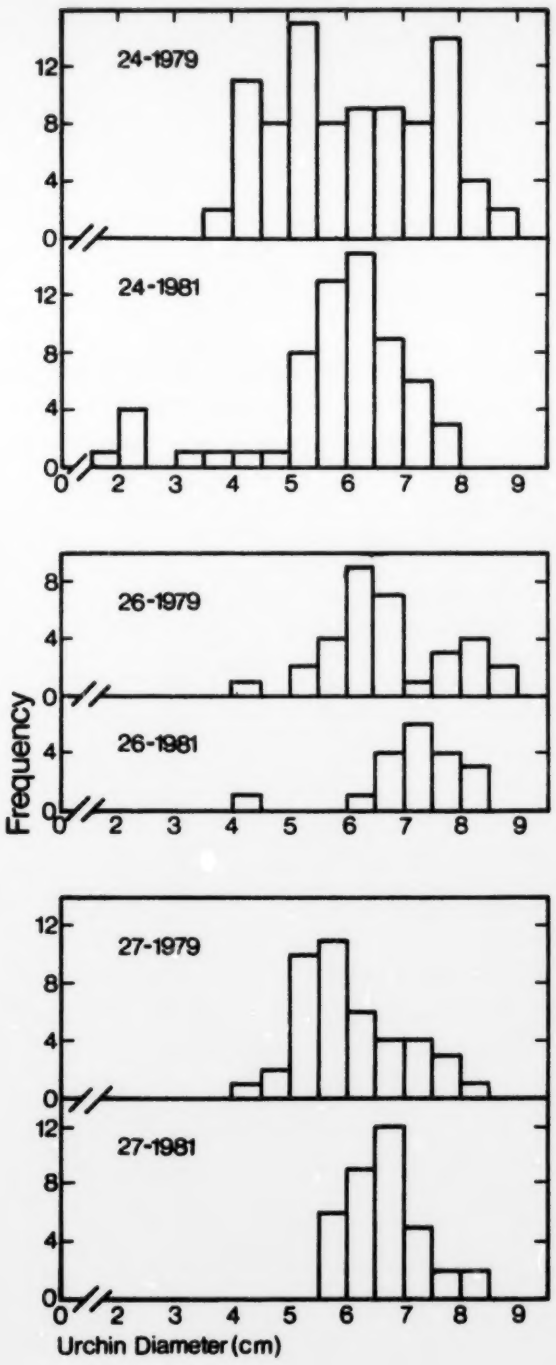

Figure 2. (cont'd)

Table 2. Results of chi-square tests comparing sea urchin size frequencies in 1979 and 1981.

Transect	Significance test	Comments
9	$P < 0.01$	More large urchins in 1981
10	-	No sizes taken in 1981
11	-	Sample size too small in 1979
12	$P < 0.05$	More large urchins in 1981
13	$P < 0.05$	More large urchins in 1981
14	$P > 0.05$	-
15	$P > 0.05$	-
18	$P > 0.05$	-
20	$P < 0.01$	More large urchins in 1981
21	$P < 0.01$	More small urchins in 1981
23	$P < 0.01$	More small urchins in 1981
24	$P < 0.01$	More large urchins in 1981
26	$P < 0.01$	More large urchins in 1981
27	$P < 0.01$	More large urchins in 1981